



REMOTE SENSING CENTRE

**PEATLAND INVENTORY OF MANITOBA
III—INTERLAKE REGION USING
LANDSAT V THEMATIC MAPPER**

Manitoba
Natural Resources
Surveys and Mapping



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PEATLAND INVENTORY OF MANITOBA

III - INTERLAKE REGION USING

LANDSAT V THEMATIC MAPPER

by

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ABSTRACT

The area inventoried is located in the south central region of Manitoba between latitudes $51^{\circ}00'$ - $51^{\circ}53'N$ and longitudes $96^{\circ}36'$ - $97^{\circ}50'W$. A supervised classification technique was used to analyze one computer compatible tape from Landsat V, Thematic Mapper, for Track 31, Frame 24, Quad 12, on the 30 August 1985. The results indicate that the highest confidence level, in terms of commercial viability, range from Sphagnum ericoid bogs > Ericoid Sphagnum bogs > Open canopy conifer with low shrub bogs > Closed canopy treed bogs.

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INTRODUCTION

1.1 Background

The vegetation cover, areal extent and quality of the peatlands in Manitoba need to be defined before determining their potential for fuel, horticulture, agriculture and forestry. Such a study falls within the mandate of the Manitoba Department of Energy and Mines to inventory the commercial deposits (> 200 h) of horticultural peat from the spectrum of wetlands within the province. This program is part of the overall integrated resource management strategy of the provincial government.

Peat was first mined in Manitoba during 1881 when the Manitoba Electric & Gas Light Co. leased 9 square miles of the Julius Bog for the purposes of manufacturing peat (Public Archives of Canada, 1881). Later, Anrep (1912), Leverin (1946), and Cameron (1951) surveyed accessible bogs and published estimates of mineable peat in Manitoba. More recently two detailed surveys by Bannatyne (1967 and 1980) were carried out on the commercially feasible Sphagnum bogs of S.E. Manitoba. In addition the Canada-Manitoba Soil Survey have mapped most of the south central areas of the province, indicating areas of organic soils. To date two reports from The Pas (Dixon and Stewart, 1984) and South East Manitoba (Stewart, et al., 1986) have been completed. Both reports indicate that satellite remote sensing of peatlands vegetation, combining manual and machine interpretation of data, does provide an estimate of the areal extent of probable exploitable peatlands but little of their underlying peat properties.

The first report was generated during 1983 from a 'quick-look' inventory of The Pas mapsheet (53°- 54°N. and 100°- 102°W.). A supervised classification was completed on LANDSAT II MSS data from a single CCT (Path 37, RW 22, June 26, 1981). Analysis of data provided an areal estimate of three peatland classes with suspected commercial potential, namely Treed Bog, Shrub-treed Fen and Graminoid-rich Fen (Dixon and

Stewart, 1984). The principal difficulty concerned the spectral confusion between fen classes and surface water reflectance. This spectral confusion of vegetation cover types restricts signature extension from single date imagery.

The second report focused on southeastern Manitoba between latitudes 49° - 50° 21'N. and longitudes 95° - 96° 10'W. A supervised classification was carried out on two computer compatible tapes for Tracks 29 and 30 on the 11th of July and 6th of September, 1984 respectively. The results indicated correct proportional representation of ericoid bog (Sphagnum (100.0)%, Treed Bog (83.2%), Shrub Fen (73.4%) and Sedge Fen (76.8%). While the shrub fen class was confused with the treed bog class (40 out of 444 sites), the ericoid bog was not confused with any other theme because of its small area and unique spectral reflection.

1.2 Peatlands as a Resource

The development of peat resources in recent years owes much of its impetus to the inventory of horticultural peat resources identified, mapped and assessed under the Canada-Manitoba Mineral Exploration and Development Agreement. Many large and small mineable peat deposits have been located and are available for peat harvesting. During 1986 seven peat deposits under licence to two principal commercial enterprises were actively stripped of 73,000 tonnes of horticultural grade peat for an estimated value of \$11 million, which when combined with additives yielded a combined value of \$13 million (Mines & Energy Statistics, 1987). Currently there are 12,000 acres (approx. 5,500h) being held by licences in 'good standing'. Because of the general drying condition experienced by our continental climate, vacuum harvesting is profitable, production-wise, to the companies with investments in this provincial resource.

1.3 Purpose of the Study

Resource data has been available since 1984 from the improved sensor technology of the LANDSAT V thematic mapper. The new sensor has more spectral bands, improved radiometric resolution and better spatial resolution (30m). This improved spatial resolution means that peatlands as small as 2 ha. may be delineated.

With this improved capability, it is our objective to produce a supervised classification of the bog and fen wetland classes in the southeastern portion of the Interlake region (NTS 62P Hecla). Training areas are located in representative bog and fen sites which were partly accessible for ground-checking.

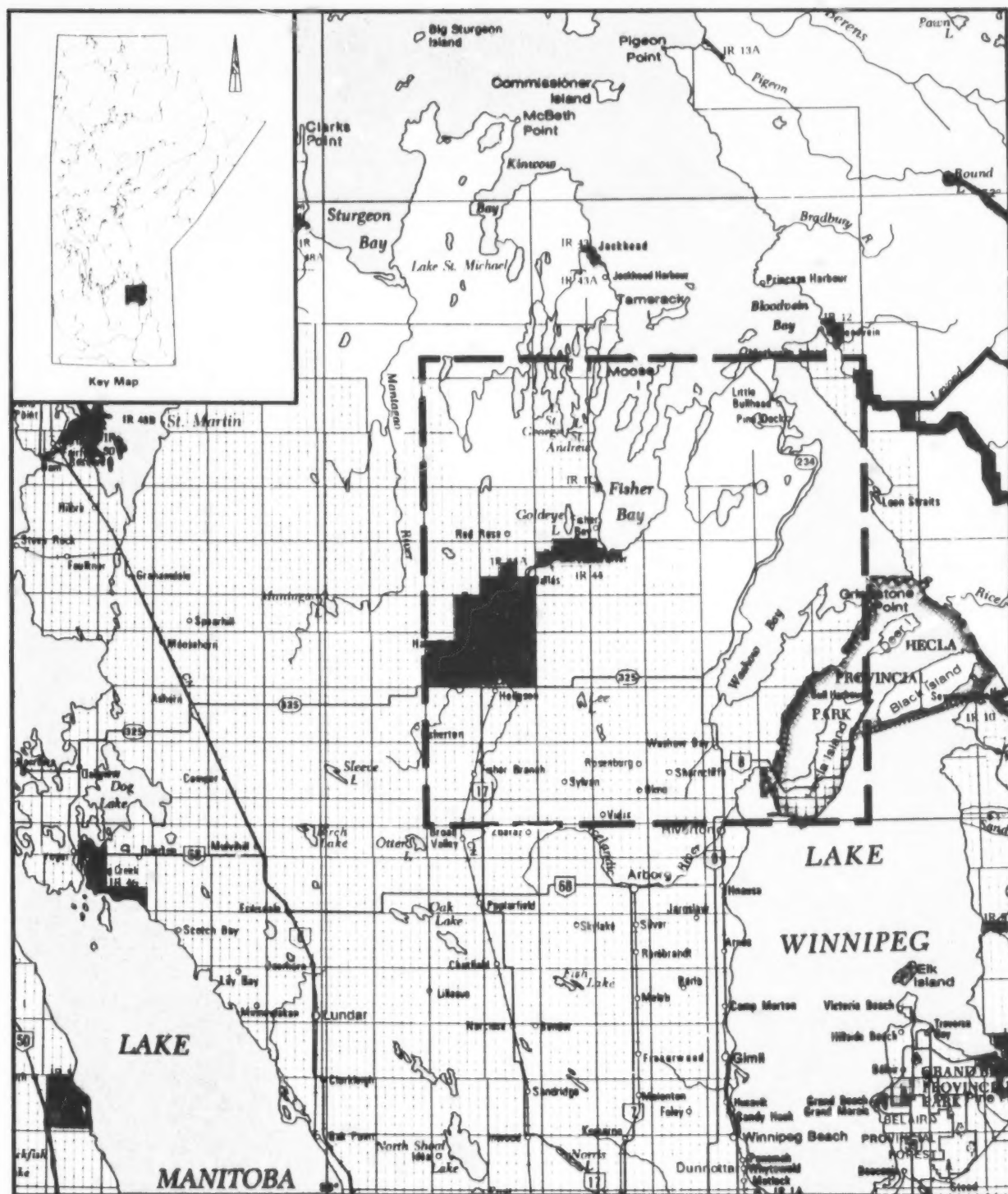
2.0 STUDY AREA

2.1 Location

The peatlands within the study area lie in the east central portion of the Interlake district of Manitoba between latitudes $51^{\circ}00'$ - $51^{\circ}53'$ N. and longitudes $96^{\circ}36'$ - $97^{\circ}50'$ W. (Fig. 1). The study area encompasses much of the Red Rose-Washow Bay area and covers some 9,000 km.²

2.2 Climate

The climate can be described as typical mid-continental with temperatures high in the summer, low in the winter and the average annual temperature range greater than equivalent latitudes near the oceans. The area is classed as sub-humid with a pronounced summer maximum of



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STUDY AREA ———

Scale 1:1 000 000

Figure 1

precipitation (7.6 cm), 70% of which falls between April and October. The degree-days or heat units range from 2,837 to 2,882; and the vegetative growing period ranges from 166 to 172 days, of which the frost free period varies from 113 to 116 days (Manitoba Soil Survey Soils report No 19; 1975).

2.3 Soils and Topography

The topography of the map area is relatively flat with elevations ranging from 217 m. (Lake Winnipeg) to the western boundaries approximating 305m. Consequently the western Interlake Till plain and the Lake Winnipeg Lowland have poor surface drainage. Much of the area is underlain with calcareous bedrock. The soils developed along the southern edge of the Boreal biome with forest litter an integral part of the A horizon. By far the largest soil group is the Organics which occur on poorly drained areas. Some 46% of the map area falls within this category. Basically in the Manitoba Soil Survey Soils Report No. 19, 1975, the organic terrain is divided into three classes of peatlands, namely forest peat (6%), Fen peat (16%) and Sphagnum peat (24%). It is the Sphagnum peat which is of interest to us in this study.

2.4 Vegetation

Rowe (1959) classified the vegetation of this area as being within the southern part of the boreal Forest region (B.15). The typical species found in the Boreal Forest are white and black spruce. Depending on site conditions, other species, mostly jack pine, aspen, balsam fir, white birch, hazel, mountain maple, snowberry, horesetails and feather mosses are frequently mixed with white spruce associations while tamarack, swamp birch, ericoids and bog mosses are associated with black spruce.

Along the many drainage channels in the area tamarack, willow and alder are common.

2.5 Disturbances

Natural and human initiated fires plus extensive selective cuttings of white spruce, black spruce and jackpine have removed most of the mature forest tree species and replaced them with the earlier succession stages rich in aspen and balsam poplars intermixed with young white spruce, white birch and balsam fir. Dry upland soils support extensive stands of young jack pine. The map area is sparsely populated and the principal activities in the central and northern areas are trapping, hunting, fishing and forestry. Along the southern boundary mixed farming is possible on some of the stony soils. Recently organic soil farming has been shown to be feasible (Organic Farmers Soil Report, 1986). The area has few roads and is traversed by a number of transmission lines.

3.0 PROCEDURES

3.1 Field and oblique Aerial Observations

Field observations were conducted during the first and last weeks of July and the first week of August 1986. The purpose was to gather data on various wetland plant communities within the study area, which would assist in the classification process of remotely sensed data. The criteria for field observation site selection were representative wetland types and accessibility by road. Existing panchromatic aerial photography at a scale of 1:15840 was photo-interpreted for each site

(Fig. 2). The aerial photography was then taken into the field to locate various wetland types and sample for plant cover and in some cases peat depth. An aerial survey was conducted during the last week of October, 1986, to assess wetlands that were not accessible by road. Aerial survey points were established along a predetermined flight path and plotted on a 1:250,000 topographic map. Each point represented a wetland type which was analyzed by an observer from a small aircraft at an altitude of 180 to 240 metres above ground level. The wetland type was recorded and an oblique photograph was taken using a 35mm camera and colour film.

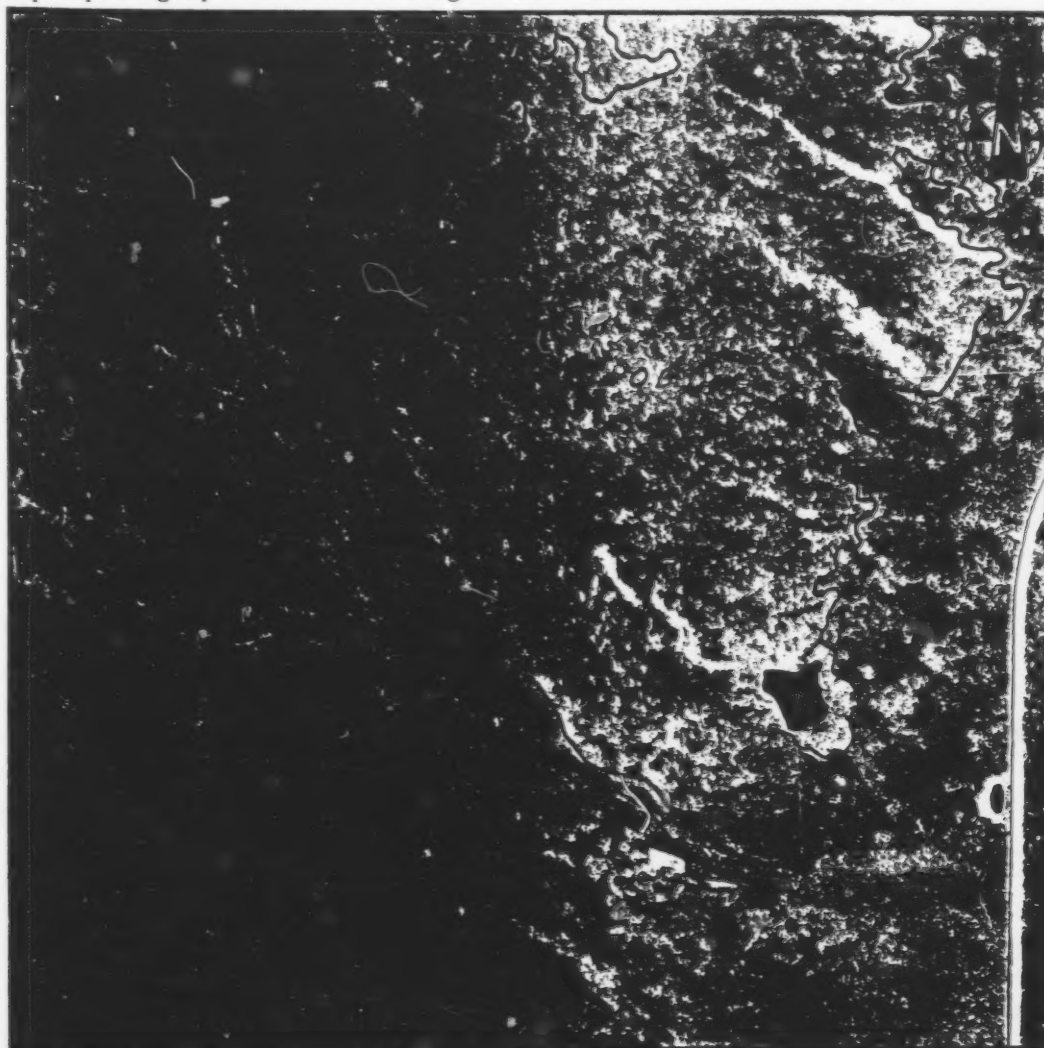


Figure 2: Aerial Photo (A24410-14) of Open Bog (O.B.), Treed Bog (T.B.) and Sedge Fen (S.F.)

3.2 Cover Type Classification

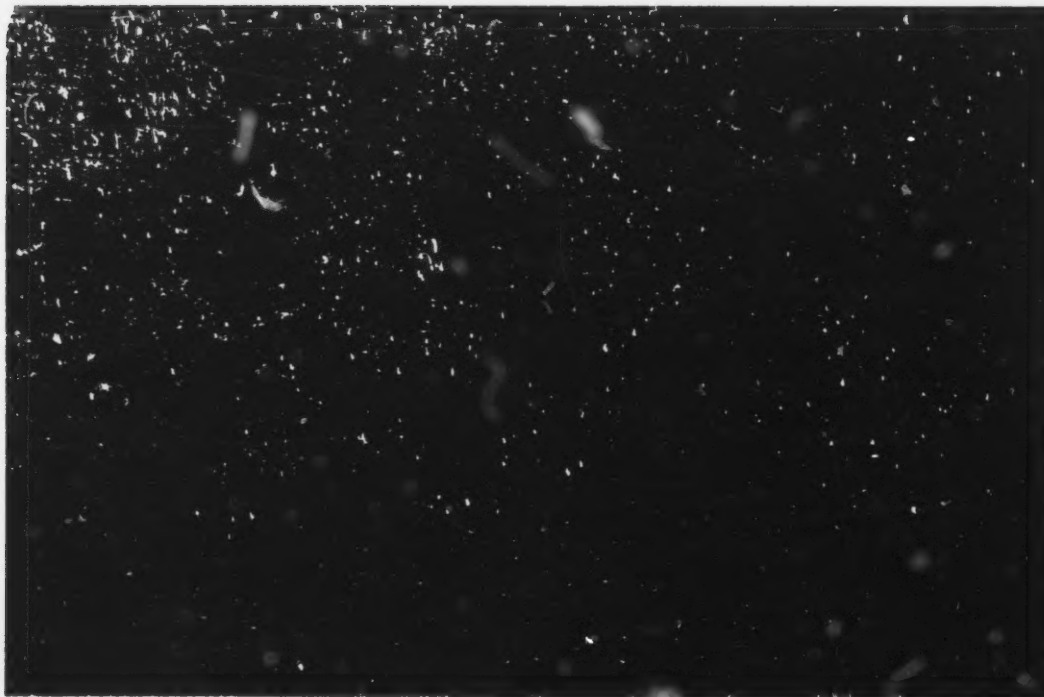
During the summer of 1987, field surveys and aerial panchromatic photographs were used to identify the following peatland types throughout the study area:

- a) Sphagnum ericoid bogs
- b) Ericoid Sphagnum bogs
- c) Open canopy treed (conifer) bogs with low shrubs
- d) Closed canopy treed bogs
- e) Sedge fens
- f) Shrub fens
- g) Marshes

Bogs are the most common and generally occur in confined topographic depressions. Vegetation cover ranges from sparse cover of black spruce and tamarack to complete tree canopy enclosure often near the edge of the depressions. Within the open areas, wet carpets of Sphagnum are common with ericoids dominating in the drier hummocky areas. Fens are commonly associated with depressional areas, minerotrophic water and drainage channels at various stages of flow. Marshes are found often along the perimeter of lakes or active drainage channels. The variable patterns caused by the degree of open canopy and the varying amounts of Sphagnum and ericoids were judged compatible with the Landsat reflectance data.

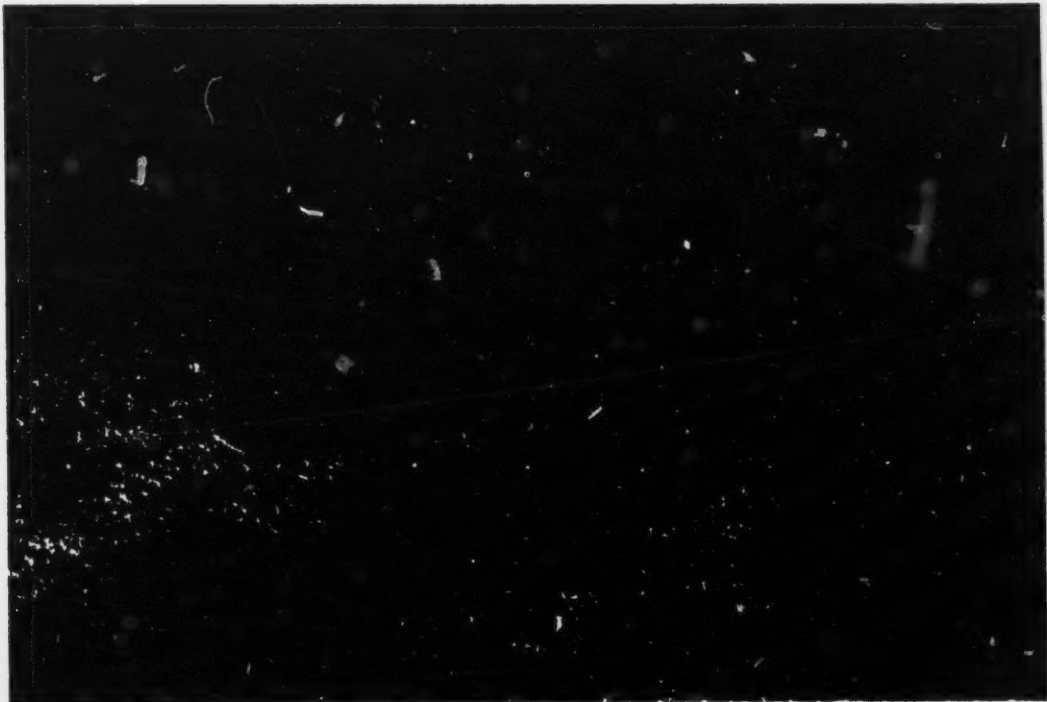
3.2.1 Sphagnum Ericoid Bogs

black spruce and tamarack have a cover of <10% and mostly occur as isolated individual trees on the slightly more elevated ridges (Fig. 3). The dominant ericoid shrub is leather leaf (Chamaedaphne calyculata) in the open areas whereas labrador tea (Ledum groenlandicum) occurs more frequently associated with tree cover. Swamp birch (Betula pumila) is the most abundant non-ericoid shrub and tends to grow on the drier areas of this bog class. Beneath the shrub layer is a continuous surface layer of Sphagnum mosses (principally Sphagnum fuscum) with pools of water common in the microtopographic depressions between hummocks.



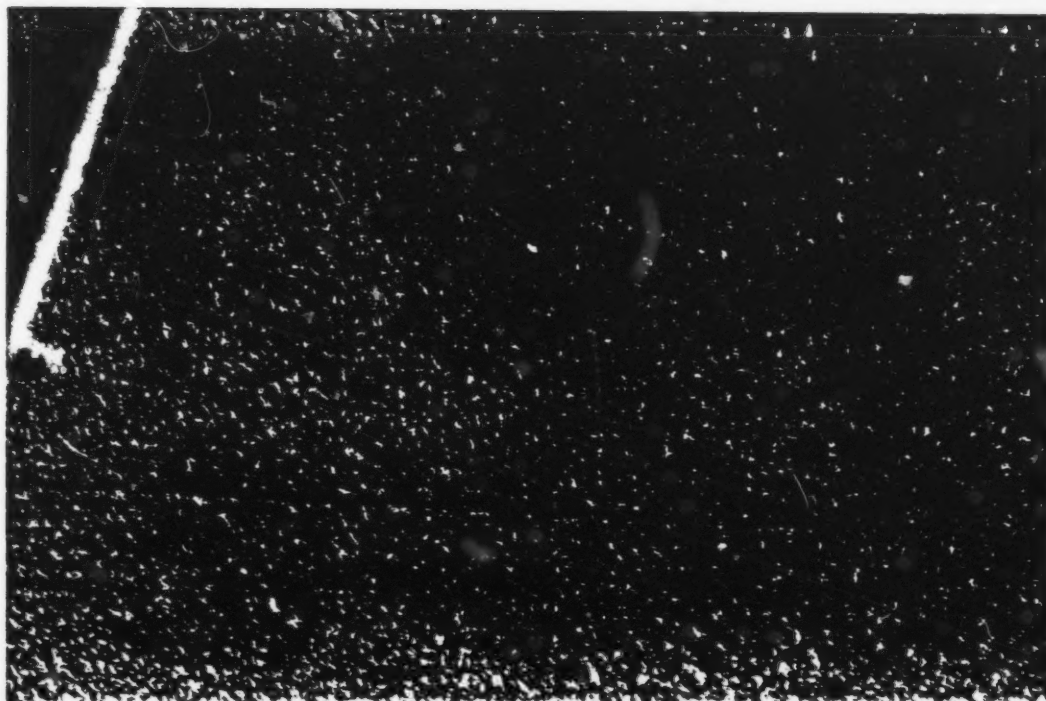
3.2.2. Ericoid Sphagnum bogs

The principal difference between this bog class and the previous class is the absence of pools of standing water and the almost continuous cover of ericoids principally leatherleaf throughout with labrador tea associated with tree cover. Tree cover is more evident and canopy closure ranges from 10 to 40% (Figure 4). Increased densities of swamp birch are encountered especially in the drier hummocky areas near tree clumps.



3.2.3 Open Canopy Treed (Conifer) Bogs with Low Shrubs

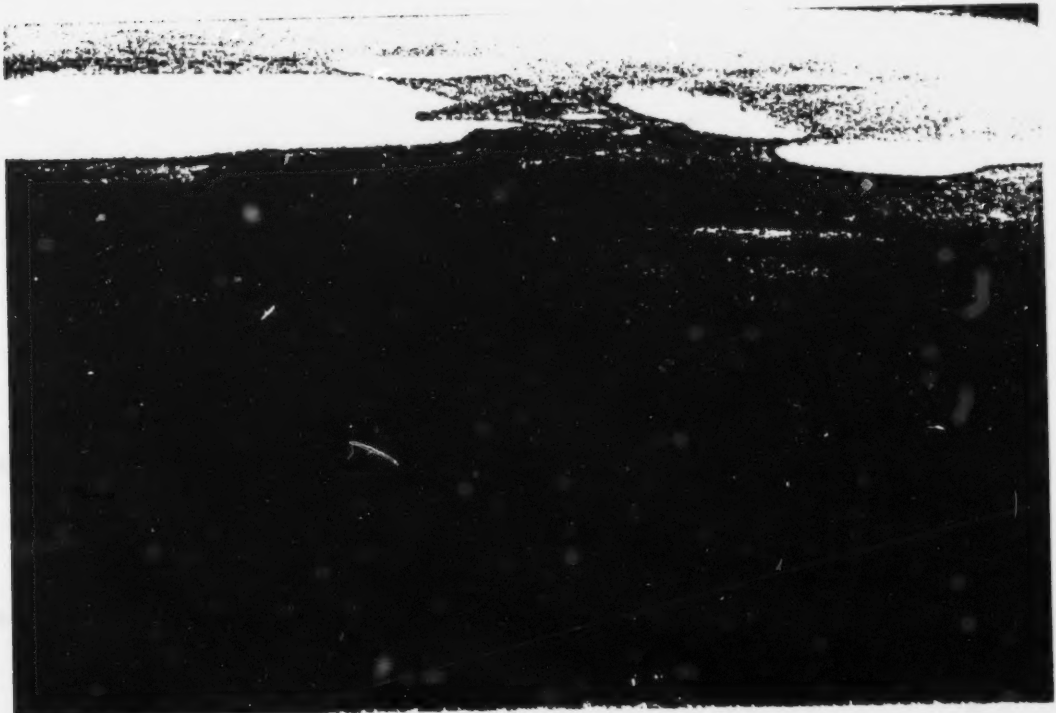
The low density of mostly stunted trees and the high density of the underlying shrubs (swamp birch and ericoids) characterize this class. The open, discontinuous cover of stunted black spruce and tamarack ranges from 30 to 60%. The understorey consists of a continuous cover of leatherleaf, labrador tea, Sphagnum mosses and lichens on the drier hummocks (see foreground of Figure 5), and is clearly visible from the air.



3.2.4 Closed Canopy Treed Bogs

This class is similar to the previous open canopy treed bog class except that the tree growth is more vigorous and the individual tree canopies are often touching (figures 5 & 6). In the understorey labrador tea occurs more frequently than leatherleaf and occasionally feather mosses grow under the more mature trees.

Often this class is subject to lightning strikes and fire burn patterns result from tree destruction and exposure of the understorey, rich in the vigorous growth of ericoids, responding to probably the enrichment of the substrate from the tree ash (Figure 6).



3.2.5 Sedge Fens

In contrast to bogs, fens are nutrient-rich wetlands with established patterns of runoff and drainage. Fens consist of peat types with high fibre (sedge) peat content and a watertable that remains at or near the surface throughout most of the year (Figure 7). Typical of the sedge fens is a vegetation rich in graminoids (grasses and sedges) of varying heights as well as scattered swamp birch, willows, sweet gale (Myrica gale). Standing waters in depressions are often colonized by cattails especially where the peat depth is shallow. The topography is flat and often are related to filling in of lakes. Some of these sites border on a marsh-type environment.

3.2.6 Shrub fens

Typical vegetation consists of graminoid-rich shrubby fens with shrub densities often approaching 50% of the surface cover (see foreground of Figure 7), grasses and sedges, mosses (Scorpidium) and scattered stunted tamarack. Standing water is most notable in the spring and early summer. Drier sites are characterized by high sedge litter, more robust shrub cover and non-Sphagnum mosses.



3.2.7 Marshes

Marshes consist of poorly drained, thin organic layers overlying calcareous till. Most of the organic soils occur in microdepressions scattered across the landscape, and are often elongated depressions in a north-west to south-east direction. Vegetation cover is mostly of sedges, grasses, cattails, and reeds. These soils must be drained before they can be used for agriculture. Many of the marshlands are currently being used for native hay production and grazing. The problems associated with wet soils normally prevents the growing of domesticated hay crops.

3.3 Data Acquisition

Landsat microfiche files were searched at the Manitoba Remote Sensing Centre to identify the most appropriate Landsat Thematic Mapper (TM) images for the study. The criteria for selection were: imagery had to be cloud free and the sun elevation provided the greatest potential for ground contrast in reflected radiation.

LANDSAT V digital data were acquired from the following: Track 31, Frame 24, Quad 12, 30-Aug.-85.

Reference data included aerial photographs, National Topographic Series (NTS) maps, vegetation sampling and aerial oblique colour photographs. Panchromatic aerial photography dated 1976 and 1978 provided coverage of the entire study area at a scale of 1:56,000 and 1:15,840 respectively.

3.4 Data Analysis

Digital image analysis of the satellite data was achieved with the Applied Resource Image Exploitation System (ARIES-II). Image analysis operations were conducted in three stages (Stewart et al., 1986). Stage one consisted of image preprocessing. Landsat TM Bands were resampled from 30 metre to 41 metre pixels to accommodate 1:50,000 mapping. Stage two resulted in the classification of the satellite data in which scattergrams were used to display cluster data in Band 4 (Y-axis) and Band 5 (X-axis). The third stage consisted of post classification filtering, manual theme assignments and the generation of output products.

3.5 Classification Accuracy

A regression analysis was used to measure the relationship between the Landsat classification (Y) and photointerpreted panchromatic aerial photography (1:15840) (X). The coefficient of determination (r^2) and the correlation coefficient (r) were calculated.

To accomplish this, segments (sampling units) were identified on the classified results. Each segment represented .62km by 2.5km on the ground. The area results for each cover class within each segment were compared to areas calculated from photointerpreted panchromatic aerial photography. These two variables were the basis for the linear regression.

4.0 RESULTS AND DISCUSSION

From the supervised classification eight 1:50,000 bog and fen vegetation cover maps were produced for an area of approximately 9,000 square kilometers. Four classes of bog were spectrally separable on the

Landsat-TM data. An aerial survey through the study area confirmed that the classified results were valid. However, these spectral differences could not be interpreted on panchromatic aerial photography. The bog categories had to be combined for the purpose of total area summary for the accuracy assessment.

The coefficient of determination (r^2) for bogs was 0.9656 and the correlation coefficient (r) was 0.983 which indicated a good fit between the photointerpreted aerial photography and the Landsat classification (Fig. 8). The coefficient of determination (r^2) for fens was 0.882 and the correlation coefficient (r) was 0.939 (Fig. 9).

4.1 Field Trip and Limitations

Validation of plant cover designations for the supervised classification were carried out by visiting sites accessible from road and by flying over the inaccessible areas in a single fixed-wing aircraft. Actual field sites examined were confined to the bog, fen and marsh classes paralleling provincial highways #224, #225, #233, #234 and the gravel roads marked on the Highways Map of Manitoba. The air flight path was routed over the principal Sphagnum ericoid bogs.

The road sites examined were mostly treed bogs with varying canopy closures plus shrub and sedge fens. The decision to include a roadside site for confirmation was based solely on cover and a minimum of 6 pixels of the theme class. For example, 4 of the 5 sites on Hwy. 234, starting 2.7 km south of Matheson Point, had a typical cover of black spruce and tamarack, an understorey of labrador tea, assorted ericoids and

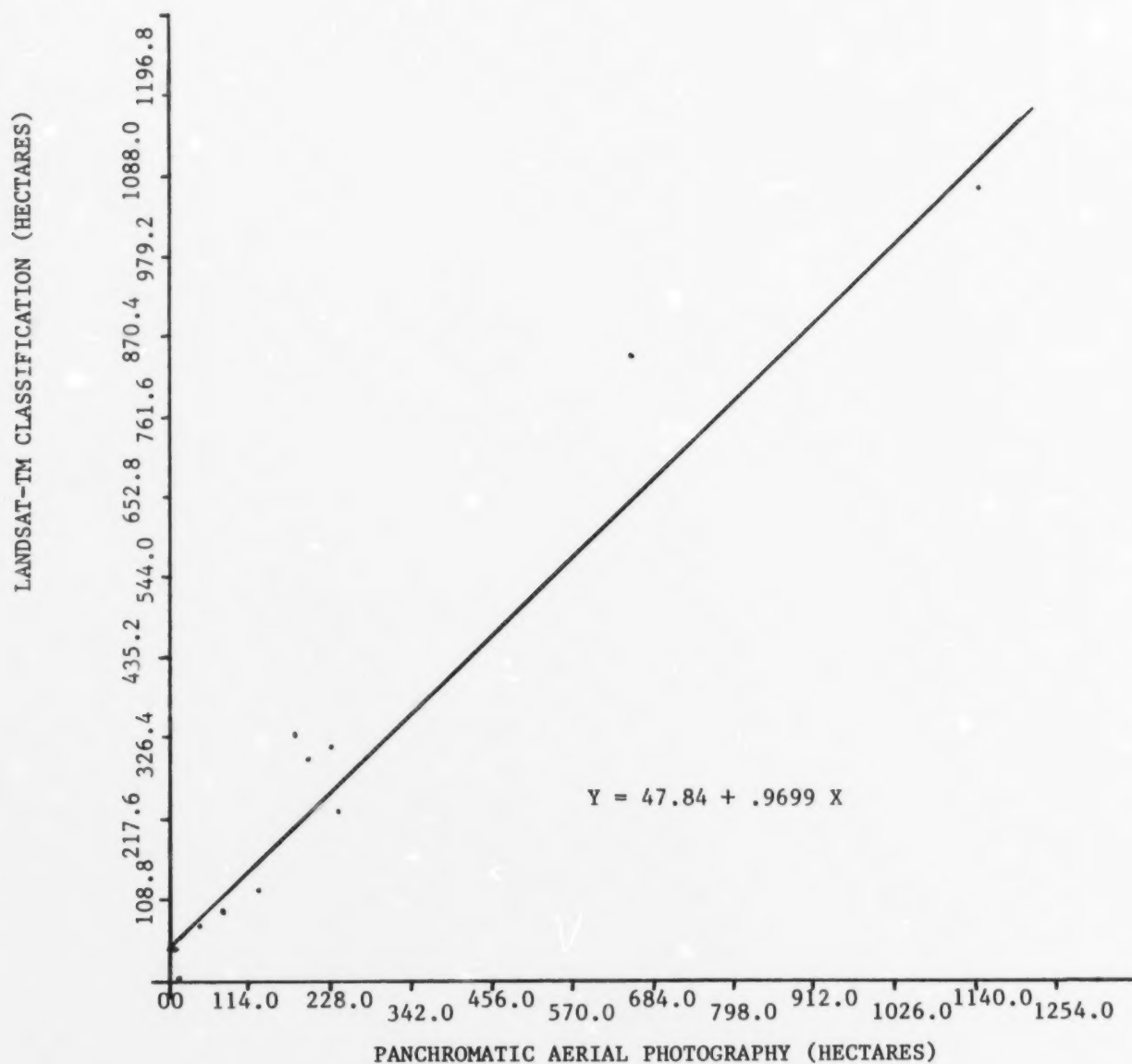


Figure 8 : Comparison of Landsat-TM Classification Data and Aerial Photography for Bogs

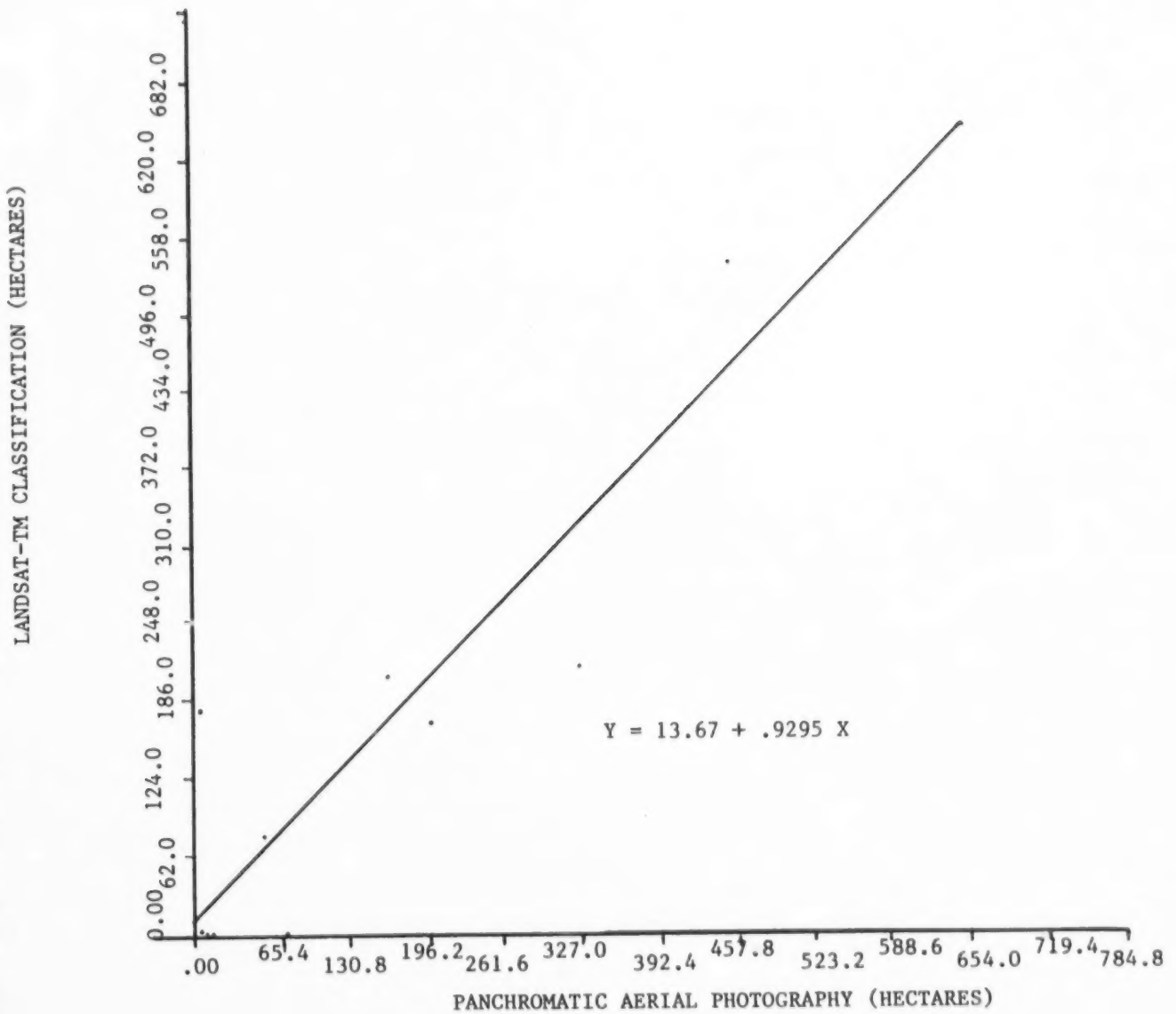


Figure 9: Comparison of Landsat-TM Classification Data and Aerial Photography for Fens

a continuous carpet of Sphagnum species (mostly S. fuscum). The peat was a rich reddish-brown horticultural grade Sphagnum peat below 35cm. In three of the sites peat depths were in excess of 1.50 m (the limit of our Hiller corer). The properties of the peat at 1 m depth were: pH 3.5 - 4.4; conductivity 27 - 53 umho; Ash (loss-on-ignition) 1.7 - 2.4%; water content 84.6 - 88.2%. One other site was in mature close-canopy black spruce (> 15m) underlain with a thin upper strata of Sphagnum peat (35 cm) grading into a woody peat (85 cm). The last site examined was a sedge fen 63.1 km south of Matheson Point with 45 cm of fibrous sedge pat. All corings were taken approximately 30 m from the road, except for the licenced areas held by fisons-Western Peat (licence since lapsed) which is located at grid reference 649 (x axis) and 562 (y axis) (Appendix Map Hecla-Grindstone). The coring was made 1 km west of Hwy 234 along a cut line.

4.2 Image Classification and Limitations

Landsat TM data was more effective in isolating bog and fen classes of the wetland spectrum than from the older MSS data. To determine the validity of each class requires reference data with greater spectral variation than is found in panchromatic aerial photography. The colour obliques taken during the airflight over the key bog and fen classes (Fig. 2-6) demonstrated that true colour aerial photography and a multistage sampling approach would provide the information required to do the necessary accuracy assessment of all wetlands classified from TM data.

The volume of mineable peat cannot be determined directly from the wetland classification although estimates based on area and spot corings (average 1.5m) would provide a working value for determining the feasibility of commercial deposits. Ground access into the prime bog class for commercial development (see appendix map Hecla - Grindstone area) was limited to a 1.8 km walk down a cut line. The peat core yielded

high grade horticultural Sphagnum of depths > 1.5m. The areal extent of this prime Sphagnum ericoid bog is approximately 16 km² which could yield an estimated 24×10^6 cubic meters of horticultural peat. To confirm these estimates, extensive fieldwork is required to correlate the depth of horticultural grade Sphagnum peat volumes with the identified wetland classes from the Landsat image.

5.0 CONCLUSIONS

A supervised classification was applied to Landsat-V data of the east central area of the Interlake (Red Rose-Washow NTS mapsheet) region of Manitoba. The spectral and spatial heterogeneity of vegetation cover types generated useful signatures of the bog class with high quality horticultural grade Sphagnum peat. Detailed botanical surveys and peat depth correlations were limited because of financial constraints. From this thematic mapper study we predict that the confidence level for mapping the commercially viable peat deposits range from Sphagnum ericoid bogs > Ericoid Sphagnum bogs > Open canopy conifer with low shrub bogs > closed canopy treed bogs.

6. RECOMMENDATIONS

A standardized procedure for commercially viable peat deposits be demonstrated using all multistage methods of analyses including peat substrate analysis. Ideally this goal can be realized with the newer, higher resolution SPOT satellite imagery. Sufficient funds for detailed field investigative support is essential. Where possible such standardized procedures should be compatible with other provincial approaches to peatland inventory.

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